

Submicrometer organic grains: Widespread constituents of the early Solar System

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Primitive meteorites and interplanetary dust particles (IDPs) contain remnants of interstellar organic matter, marked by anomalous H and N isotopic ratios [1]. These isotopic anomalies are attributed to mass fractionation during chemical reactions at cryogenic temperatures (10 – 100K) in a cold molecular cloud. Significant variations in the chemistry and isotopic compositions of organic compounds within and between these samples suggest varying histories of alteration and dilution of the presolar components.

Recent studies have reported large H and N isotopic anomalies preserved in sub- μm organic inclusions in both meteorites and IDPs [2]. In the Tagish Lake meteorite, the largest H and N isotopic anomalies are associated with sub- μm , hollow organic globules [3]. The common physical, chemical, and isotopic characteristics of these globules suggest that they formed before being incorporated into their parent meteorite. These organic globules probably originated as organic ice coatings that formed on preexisting ice or mineral grains in a cold molecular cloud. Radiation driven photochemistry may have processed them into refractory organic grains. This model implies that submicrometer organic grains were widely distributed throughout the solar nebula during the epoch of planet formation.

Submicrometer organic particles were detected by the Giotto and Vega encounters with comet Halley, termed CHON particles based on their major element chemistry. The first direct samples of cometary dust (comet Wild-2) were returned by the Stardust spacecraft in January 2006. These samples exhibit widely varying, fine grained mineralogy similar to anhydrous IDPs, including submicrometer carbonaceous grains. The submicrometer organic grains from comet Wild-2 exhibit H and N isotopic anomalies of similar magnitude to those commonly observed in primitive meteorites and IDPs [4,5].

Isotopically anomalous, submicrometer organic grains have now been observed in meteorites, IDPs, the Oort-cloud comet Halley, and the Kuiper-belt comet Wild-2, suggesting that such grains were prevalent throughout the protoplanetary disk.

References: [1] Messenger, S & Walker RM in *Astrophysical Implications of Laboratory Study of Presolar Materials*, p. 545 [2] Busemann H. *et al.* (2006) *Science* 312, 727 [3] Nakamura-Messenger *et al.* (2006) *Science* 314, 1439 [4] McKeegan K.D. *et al.* (2006) *Science* 314, 1724 [5] Matrajt G. *et al.* (2007) LPS, Abstract #1201